Chapter 3
Classification of Breast Lesions in Frontal Thermographic Images Using a Diagnosis Aid Intelligent System

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ABSTRACT

This study aims to assess the breast lesions classification in thermographic images using different configuration of an Extreme Learning Machine network as classifier. In this approach, the authors changed the number of neurons in the hidden layer and the type of kernel function to further explore the network in order to find a better solution for the classification problem. Authors also used different tools to perform features extraction to assess both texture and geometry information from the breast lesions. During the study, the authors found that the results changed not only due to the network parameters but also due to the features chosen to represent the thermographic images. A maximum accuracy of 95% was found for the differentiation of breast lesions.

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INTRODUCTION

Breast cancer is the most common type of cancer among women worldwide. According to the World Health Organization (WHO), 1.7 million people are affected by this disease each year. In Brazil, breast cancer corresponds to 28% of new cases of cancer per year. Even having a good prognosis, this disease is still responsible for the highest cancer fatality rate in the female population. According to WHO, early detection of tumors, which is the identification of cancer in early stages, is essential in order to reduce mortality from the disease (World Health Organization (WHO), 2014).

Nowadays, breast cancer screening is performed using many imaging techniques. The gold standard for the diagnosis of this disease is mammography. However, there are several limitations associated to it. This technique consists of an x-ray scanning of the breast, which is an ionizing radiation. Therefore, it already is a risk factor for the patient. Furthermore, mammography can only show anatomical changes in the region, which are usually only noticed when the disease is already in a more advanced stages. Thus, diagnosis at early stages becomes extremely difficult. To minimize the exposure of patients to ionizing radiation and seeking early identification of the disease, other techniques such as ultrasound, magnetic resonance imaging and thermography are being explored.

The thermography is based on the acquisition of images that present the temperature distribution of a surface. This imaging technique uses an infrared camera to acquire the images. In general, the camera captures infrared radiation emitted by the surface of interest. In breast thermography there is no need for invasive procedures or exposure of the patient to ionizing radiation. Moreover, the technique allows the investigation of physiological changes from the analysis of temperatures in the region. In the case of cancer cells, there is an increase in local metabolism, directly interfering on blood flow, and thus increasing the region temperature. In general, these physiological changes may appear up to 10 years before any anatomical change, favoring the diagnosis in early stages of the disease (Etehadtavakol & Ng, 2013).

One of the main challenges of imaging diagnosis is clinical variability. The fact that diseases behave differently in different individuals makes it difficult for professionals to extract useful information from the images. This fact leads to great variability in the diagnosis provided to the patient. So, the same case is often diagnosed differently by different professionals (McKinlay et al., 1998). Computer Aided Diagnosis (CAD) systems is a tool that has been explored worldwide to overcome this challenge. In these systems, computational tools are used to assist health professionals in the analysis of medical examinations in many areas (Acharya et al., 2012; Aguiar Junior et al., 2013; Andrade, Santana & Santos, 2018; Azevedo et al., 2015; Belfort, Silva & Paiva, 2015; Cheng et al., 2005; Cordeiro, Santos & Silva-Filho, 2016; Resmini et al., 2012; Rodrigues, et al., 2018; Santana, et al., 2018).

In this scenario, several groups are dedicated to the study of computational techniques for the identification of lesions in breast thermograms. Aguiar Junior et al. (2013) performed tests using multilayer perceptron as a classifier to detect the existence of lesions in breast thermographic images, obtaining accuracies of about 75%. Resmini et al. (2012), on the other hand, obtained results close to 90% of accuracy using other classifiers (SVM, KNN and Naive Bayes) to detect the existence of breast lesion. Belfort, Silva & Paiva (2015) introduced another method of breast lesion detection in thermographic images, wherein they obtained an accuracy of around 78% using Jaccard Similarity Index and Artificial Crawlers.

In the study of Martins et al. (2011), they used statistical attributes and texture descriptors to represent images. The authors tested the Support Vector Machine (SVM), Naive Bayes, Linear Discriminant Analysis (LDA), and K-Nearest Neighbor (kNN) classifiers. Using cross-validation and kNN, they achieved results of up to 92.5% accuracy. Burges (1998), on the other hand, used Fourier descriptors to